TPC electronics options

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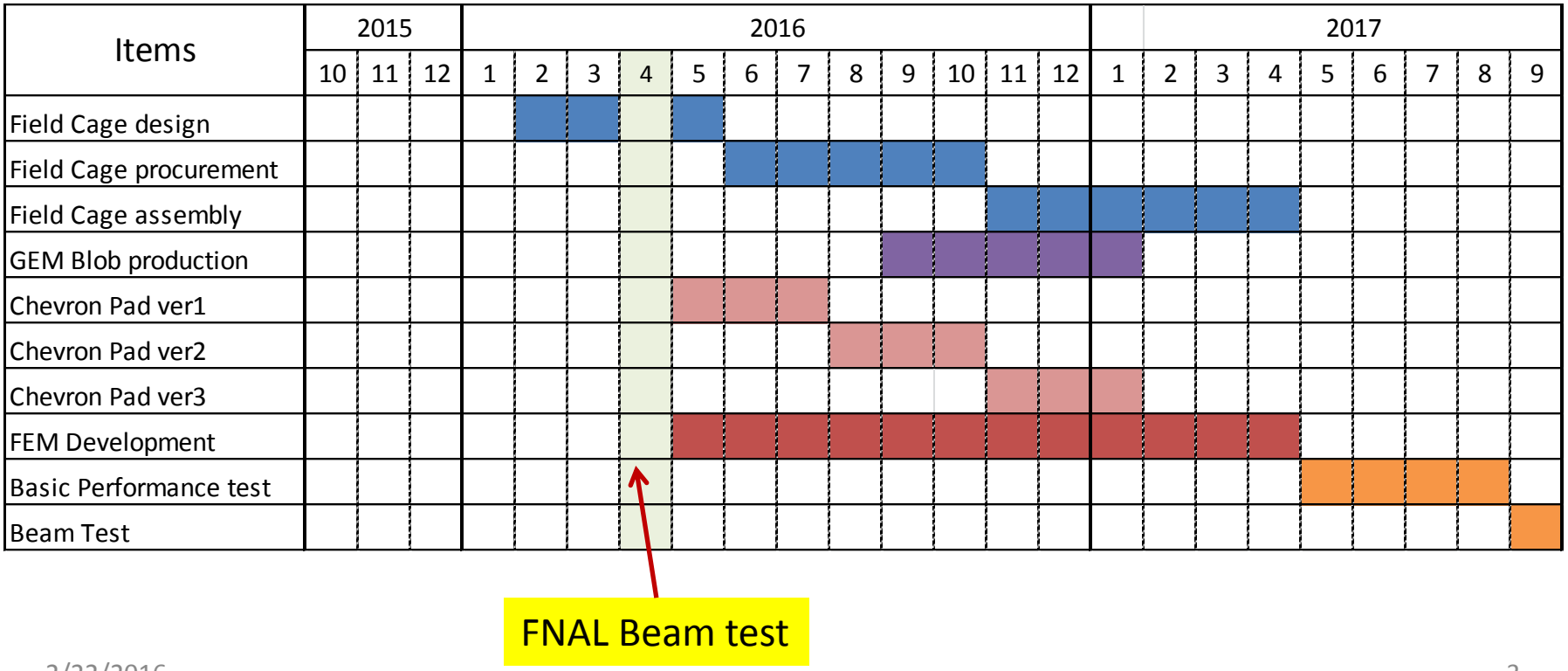
Possible options considered

- ALICE TPC – uses SAMPA chips
  - We will hear from Ken more detail on the progress today
- STAR iTPC – also uses SAMPA chips
  - They are expecting to receive proto-type of SAMPA chips this April.
  - If they figured out that they can't receive in time, they will reuse current TPC electronics (PASA+ALTRO). We need polarity-change amp. in addition.
  - They will decide in April which way to go.
- DREAM option
  - For test experiments, we can use a board that can handle 512 channels (they are willing to lend us). TS will visit Sacley and learn how to use it.
  - For mass production, we have to discuss with Sacley people about the cost
- ATLAS VMM option (John pointed it to me)
  - An ASIC called VMM is developed here in BNL, and intended to be used both for negative (e.g. Micromegas) and positive signals
  - Haven't contacted to the people involved.
  - Can be operated in continuous mode at 1MHz/channel, 10bit ADC.
  - Needs engineering for peripheral circuit and board design

Readout situation

- We need electronics to readout. Based on the schedule outlined below, the electronics should be ready by the end of April next year
  - Roughly, one year from now

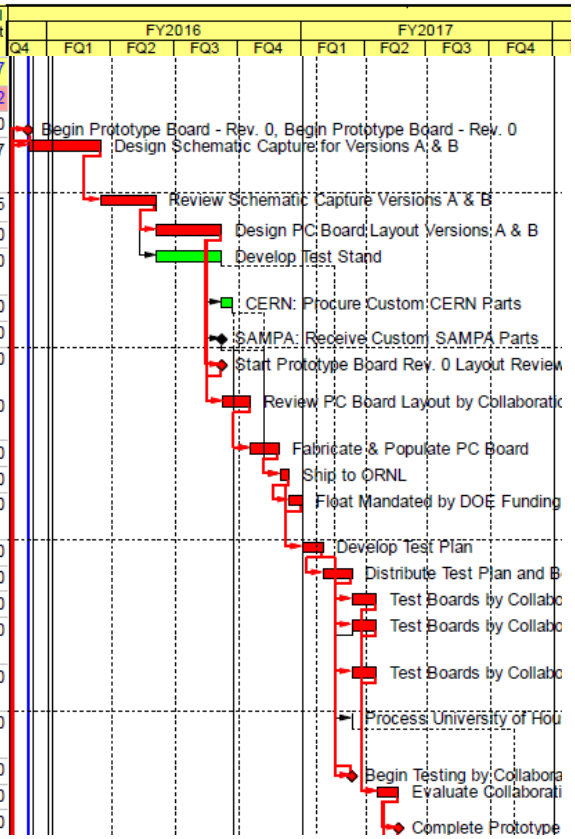
- We may want to establish a readout scheme that is also good for the final version if possible



ALICE schedule from WBS last year

- The very first version of proto-type will be produced by the end of FY16
  - I thought they will produce ~10% of total. I should check
- One option is to join the test board effort?

Activity ID	Activity Name	Rem Dur	Start	Finish	Total Float	Budgeted Total Cost
ALICE 1.1.2	Electronics	742d	01-Oct-2015	28-Sep-2018	0d	$3,158,369.87
ALICE 1.1.2.1	Prototype Board - Rev. 0	360d	01-Oct-2015	20-Mar-2017	0d	$480,100.52
TPC-E-Mi10	Begin Prototype Board - Rev. 0	0d	01-Oct-2015		0d	$0.00
TPC-E-1110	Design Schematic Capture for Versions A & B	66d	02-Oct-2015	13-Jan-2016	0d	$121,153.47
TPC-E-1120	Review Schematic Capture Versions A	55d	14-Jan-2016	01-Apr-2016	0d	$100,718.45
TPC-E-1130	Design PC Board Layout Versions A & B	66d	04-Apr-2016	06-Jul-2016	0d	$56,743.00
TPC-E-1140	Develop Test Stand	66d	04-Apr-2016	06-Jul-2016	124d	$122,203.60
TPC-E-1160	CERN: Procure Custom CERN Parts	12d	07-Jul-2016	22-Jul-2016	17d	$6,180.00
TPC-E-Mi12	SAMPA: Receive Custom SAMPA Parts	0d	07-Jul-2016		29d	$0.00
TPC-E-Mi15	Start Prototype Board Rev. 0 Layout Review by Collaboration	0d	07-Jul-2016		0d	$0.00
TPC-E-1150	Review PC Board Layout by Collaboration	28d	08-Jul-2016	16-Aug-2016	0d	$0.00
TPC-E-1180	Fabricate & Populate PC Board	30d	17-Aug-2016	28-Sep-2016	0d	$20,660.00
TPC-E-1190	Ship to ORNL	10d	29-Sep-2016	12-Oct-2016	0d	$530.00
TPC-E-1185	Float Mandated by DOE Funding Profile Gap	13d	13-Oct-2016	31-Oct-2016	0d	$0.00
TPC-E-1200	Develop Test Plan	20d	01-Nov-2016	30-Nov-2016	0d	$18,502.80
TPC-E-1210	Distribute Test Plan and Boards to Coll	22d	01-Dec-2016	10-Jan-2017	0d	$2,120.00
TPC-E-1220	Test Boards by Collaborator ORNL / UT	26d	11-Jan-2017	16-Feb-2017	0d	$0.00
TPC-E-1230	Test Boards by Collaborator University of Houston	26d	11-Jan-2017	16-Feb-2017	0d	$3,837.60
TPC-E-1250	Test Boards by Collaborator - University of Bergen	26d	11-Jan-2017	16-Feb-2017	0d	$0.00
TPC-E-1260	Process University of Houston Subcontract Fee	1d	11-Jan-2017	11-Jan-2017	25d	$6,890.00
TPC-E-Mi17	Begin Testing by Collaborators	0d	11-Jan-2017		0d	$0.00
TPC-E-1270	Evaluate Collaboration Feedback	22d	17-Feb-2017	20-Mar-2017	0d	$20,561.60
TPC-E-Mi19	Complete Prototype Board - Rev. 0 (RR)	0d		20-Mar-2017	0d	$0.00



Current TPC electronics cost

Test Stand Modification	30	$8,000.00	TPC-E-2180
Assemble and test prototype electronics: preproduction prototype	20	$3,000.00	TPC-E-2230
Review and write design change specifications	25	$43,000.00	TPC-E-2260

BOE prepared

1.3.4.10.1.3

Items	Duration (d)	costs	Notes
Final external design review	20	$33,000.00	TPC-E-3120
Procure all components needed for TPC FEC production	20	$750,000.00	TPC-E-1180, labor not included
purchase a power supply module	5	$84,000.00	Just to order, labor not included
Fabricate and assemble TPC FEC: production	55	$220,000.00	TPC-E-2180
Test and qualify TPC FEC production	55	$40,000.00	TPC-E-1230

Not listed in the WBS

Items	Duration (d)	costs	Notes
Shipping fee (to ORNL)	10	$600.00	TPC-E-1190
Proess University of Houston Subcontract fee	1	$6,900.00	TPC-E-1180
Final Vendor Evaluation and Selection	70	$22,000.00	TPC-E-3110
FY16, Mgmt coord, contributed LOE and Travel	270	$49,000.00	TPC-TR-FY16
FY17, Mgmt coord, contributed LOE and Travel	250	$42,000.00	TPC-TR-FY17
FY18, Mgmt coord, contributed LOE and Travel	200	$43,000.00	TPC-TR-FY18

Total

Total Time (days, listed in WBS)	750	*Not accounting for any parallel job splitting
Total Costs	$1,869,500.00	
Additional Costs for labor	$561,600.00	* used 8hrs/day, $120/hr * labor days: 750 - 165 (parts procurement and fabrication) = 585 days * maybe double counting the labor cost for design/layout (correspoding to $270,000.00)

*** The number in notes are the pointer to the ALICE TPC electronics WBS

*** For actual material costs related to fabrication of boards, I scaled the costs by the factor of 2.5; We assume 200K channels, while ALICE TPC upgrade, it is 550K channels. 550/200=2.75, so 2.5 is a conservative estimate of the cost of fabrication

Almost complete copy of ALICE WBS scaled by the # channels (560K -> 200K)

We are now for STAR iTPC electronics

- STAR is planning to double # of pads for the inner TPC (iTPC)
  - Currently 40K pads are readout. It's going to be 80K pads
  - Total pads for inner+outer will be 175K.
  - The idea is to instrument 80K channels with new electronics.

- They decided to design the new electronics with so-called SAMPA chips
  - New chips employed for ALICE TPC upgrade
  - Replacement of PASA+ALTRO chips currently used.
    - CSA + Shaper + ADC + some controlling functions

- Old 40K electronics will be available for anyone?
  - c.f., sPHENIX TPC needs 180-200K channels in the end.

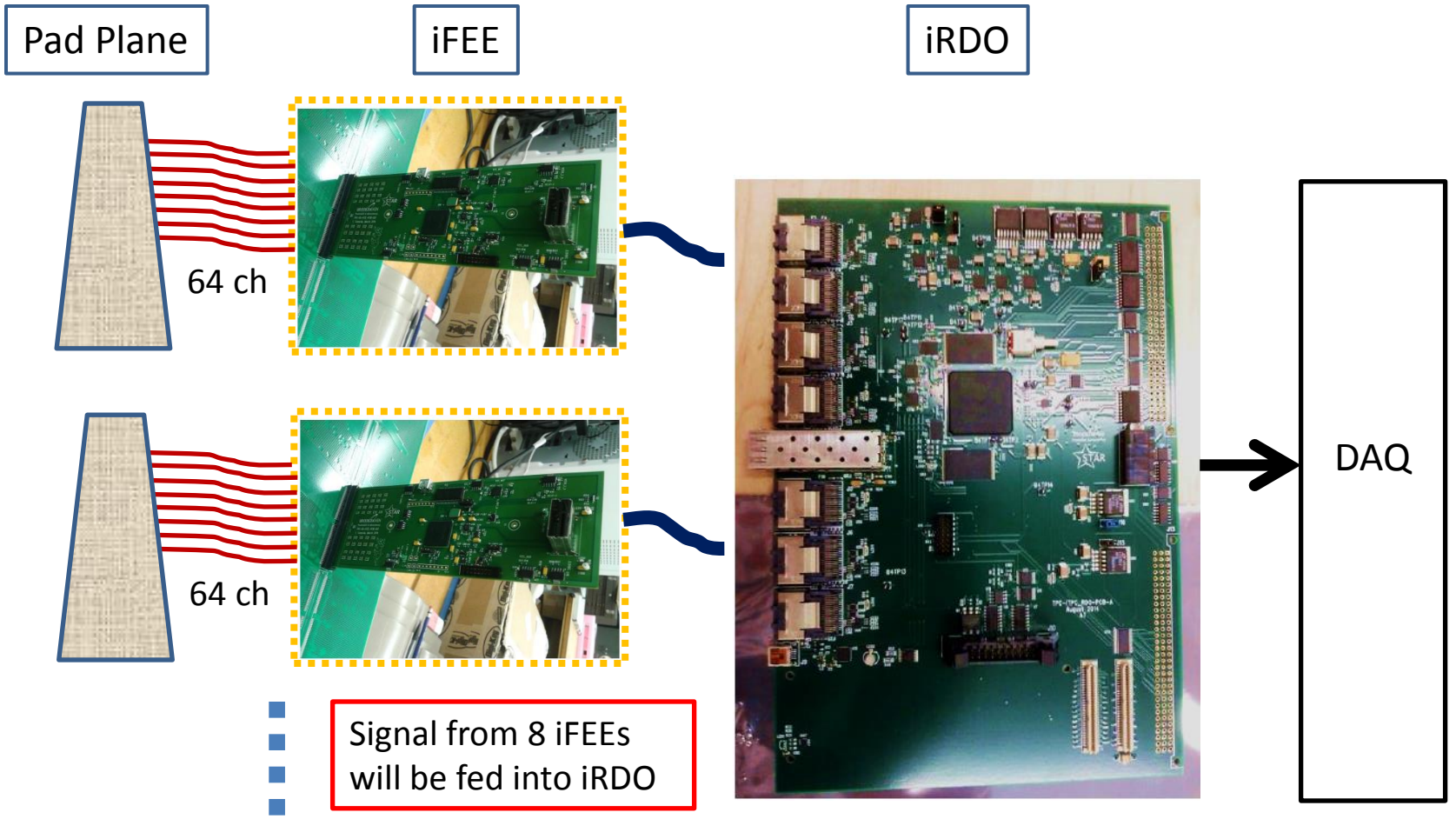
Descoping option 1

- Follow the current STAR's development plan
  - It would be ideal to fabricate all of 180K channels
    - Parts including SAMPA used for the current design may not be available later.
    - If we fabricate only X channels now, (180K-X) channels may be fabricated with a new design and thus new parts.
    - Another development effort may be needed.

- Schedule of SAMPA chips
  - The first non-packaged SAMPA chip should come out early June
  - A prototype testing board for the non-packaged chips is designed and will be manufactured by ALICE-affiliated French group by July.
    - Tonko will get one board for local STAR preliminary tests.
  - The packaged chip is expected in mid/late July at which point STAR will have their own board for further testing and other integration

- No formal design of the electronics exists at this moment
  - Cost estimate for 80K channels in the following slide.

Readout scheme



From Tonko's slides (80K channels)

We have to figure out the cost for labor!

Presented in Jan, 2016

Cost

	# items	# with spares	$ per item	$ all	With contingency (20%), overhead (56%)
SAMPA	2640	3500	$44	$154k	
iFEE	1320	1580	$130 (wo SAMPA)	$206k	
iRDO	96	116	$1300	$151k	
DAQ Receiver	24	26	$3500	$91k	
Cables, fibers, misc	-	-	-	$50k	
Power Supplies	48	52	$600	$32k	
DAQ PC	24	26	$3000	$80k	
Totals				**$764k**	**$1430k**

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From Tonko's slides

We could use the prototype iFEE for the current TPC development under BNL LDRD

Presented in Jan, 2016

Schedule

	2016	2017	2018 early	2018 late
padplane	prototype test produce		start sector installation	end sector installation
iFEE	evaluate SAMPA prototype with SAMPA	final version produce 1 sector's worth	produce all PCBs vet PCB purchase all components install into 1 sector & test	SAMPA arrives mount SAMPA & components Q&A install all full system test
iRDO	prototype 2	final version produce 1 sector's worth	produce & Q&A all install into 1 sector & test	install all full system test
Power Supplies Trigger Cables Fibers	evaluate	evaluate test	purchase & install all full test using 1 sector's worth	full system test
Receiver Cards	prototype test	final version	purchase & install all full test using 1 sector's worth	full system test
DAQ PCs	develop drivers	final drivers & software... specification	purchase & install all full test using 1 sector's worth	full system test

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Descoping option 2

- Use of old STAR iTPC electronics
  - 40K channels for free, which readouts ~1/5 of the TPC
    - One may even have to reduce the number of pads to be readout
  - Old electronics is similar to the current ALICE TPC electronics
    - PASA+ALTRO chips. The chips are for unipolar signal (positive)
    - STAR uses MWPC for readout system. The polarity is opposite for the GEM readout (MWPC: induced charge, GEM: direct charge)
  - No more channels are available nor additionally produced.
    - No more PASA+ALTRO chips are available
    - Or, do we even ask ALICE to provide their electronics?
  - We have to develop a polarity inverting pre-amplifier
    - This is not difficult, and straightforward.
    - Since the form factor of STAR iTPC and sPHENIX TPC are different, we have to develop this kind of interface board anyway.
    - Costs for this development should be estimated.